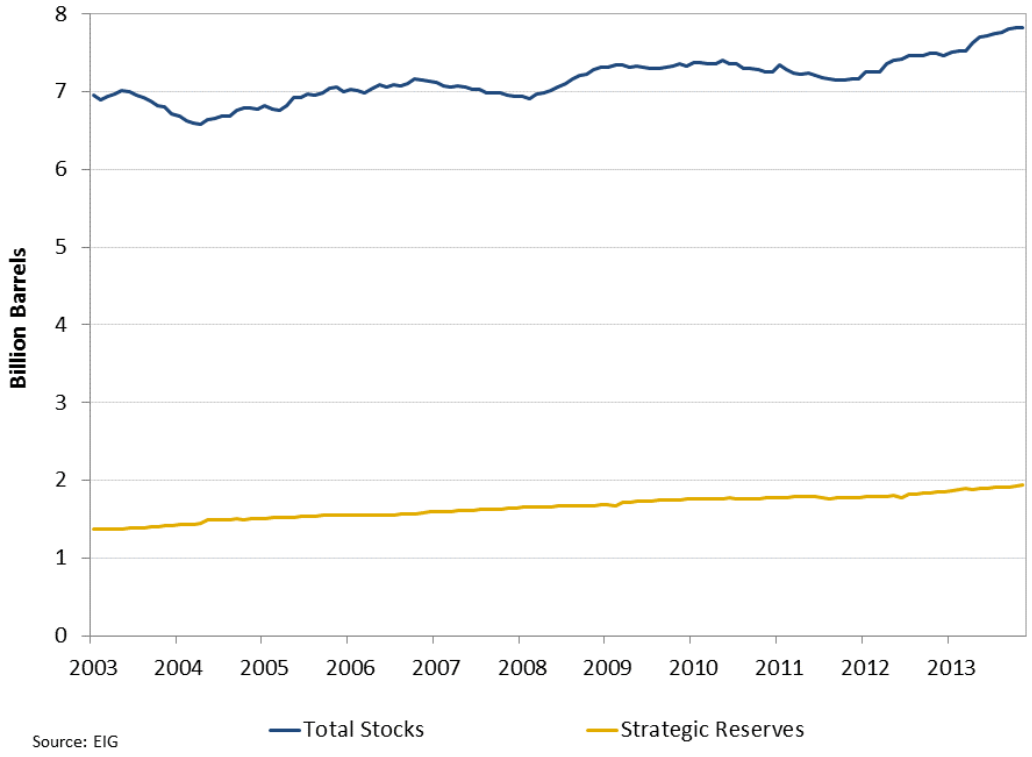
The PKVerleger LLC But-For Model

In order to assess the impact of the renewable fuel standard (RFS) program on consumer gasoline prices, we construct a model of global crude oil prices. Ethanol use in the U.S. has removed a substantial portion of crude oil demand from the world market, which, under the tight supply environment over the past several years, has produced a material reduction in price. The model calculates the Dated Brent (DB) oil prices that would have prevailed "but-for" the RFS program using an econometric approach that relates changes in DB prices to changes in inventories and seasonal variables.

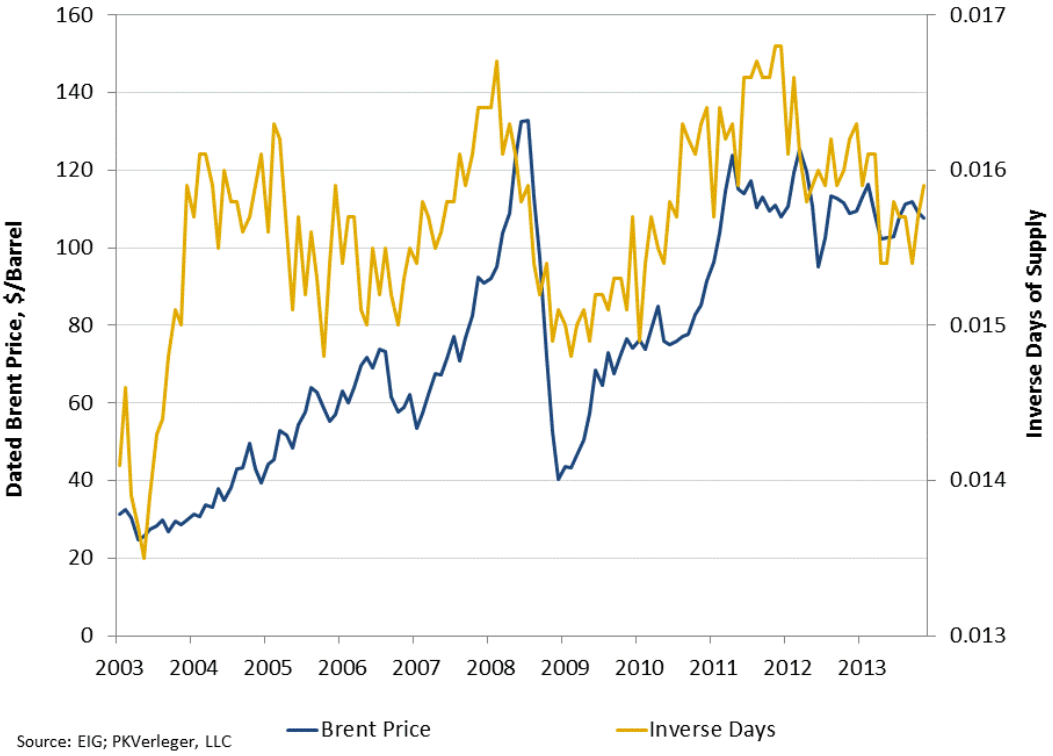
Energy Intelligence Group (EIG) publishes detailed data on inventories held across the globe and enables analysts to separate commercial inventories from strategic stocks. Figure 1 shows data on total global stocks and strategic stocks. Governments control strategic stocks, which account for approximately 16% of global inventories. Experience shows that these stocks have been "sterilized," that is, they are never used and therefore do not factor into price formation. In this study we compare the movement of commercial stocks and prices. For analytical purposes, we compare the price movement with the inverse of stocks relative to consumption.

Figure 1: Monthly Global Commercial and Strategic Inventories of Crude Oil and Products, 2003–2013



The ratio of stocks to consumption indicates the days of supply of available inventories. Economic theory would predict that a rise in inventories relative to consumption would lead to lower prices, all other things being equal. Using inverse days of supply as the inventory measure, one would expect to see prices rise when inverse days rise and fall when inverse days decline. Figure 2 compares inverse days of supply with the estimated DB price, which visually depicts how the two series tend to move together. The first task in providing statistical support for what Figure 2 indicates is to identify the empirical linkage between changes in the inverse of global days of commercial inventory coverage and changes in prices.

Figure 2: Inverse Days of Commercial Supply vs. Dated Brent Price
January 2003 to November 2013



To accomplish this, we regressed monthly data on the crude price change on the change in a sequence of current and lagged values of inverse days of supply and seasonal dummy variables. The equation took the form:

$$\Delta Pt = \alpha + \beta 1\ \Delta(1/dayt\ ) + \beta 2\ \Delta(1/dayt\text{-}1) + \beta 3\ \Delta(1/dayt\text{-}2) + \beta 4\ \Delta(1/dayt\text{-}3) + \beta 5\ JA + \beta 6\ MA + \varepsilon$$

P_t represents the DB price; 1/day represents the reciprocal of commercial days of supply with the subscript identifying days of supply at the end of the current month (current consumption divided by end-of-month stocks), the previous month, two months previous, and three months previous;

and JA is a dummy for the January-April period and MA for the May-August period. The parameters α and β_1 through β_6 are estimated using standard statistical techniques.[1]

We estimated the model using the monthly data shown in Figure 2 for the period 2006 through 2013. Table 1 lists the estimated parameters and the standard summary statistics.

Table 1: Estimated Parameters and Summary Statistics for Inverse Days of Supply Price Model

Parameter	Coefficient	Standard Error	t-Statistic
α	-2.3		
β_1	5,203.5	2,562.0	2.03
β_2	8,432.2	2,731.8	3.09
β_3	6,379.7	2,694.1	2.39
β_4	3,003.0	2,440.4	1.23
β_5	5.2	1.7	3.08
β_6	2.8	1.7	1.69

$R^2 = 0.183$

Standard Estimate = $6.69 per barrel

Source: PKVerleger LLC.

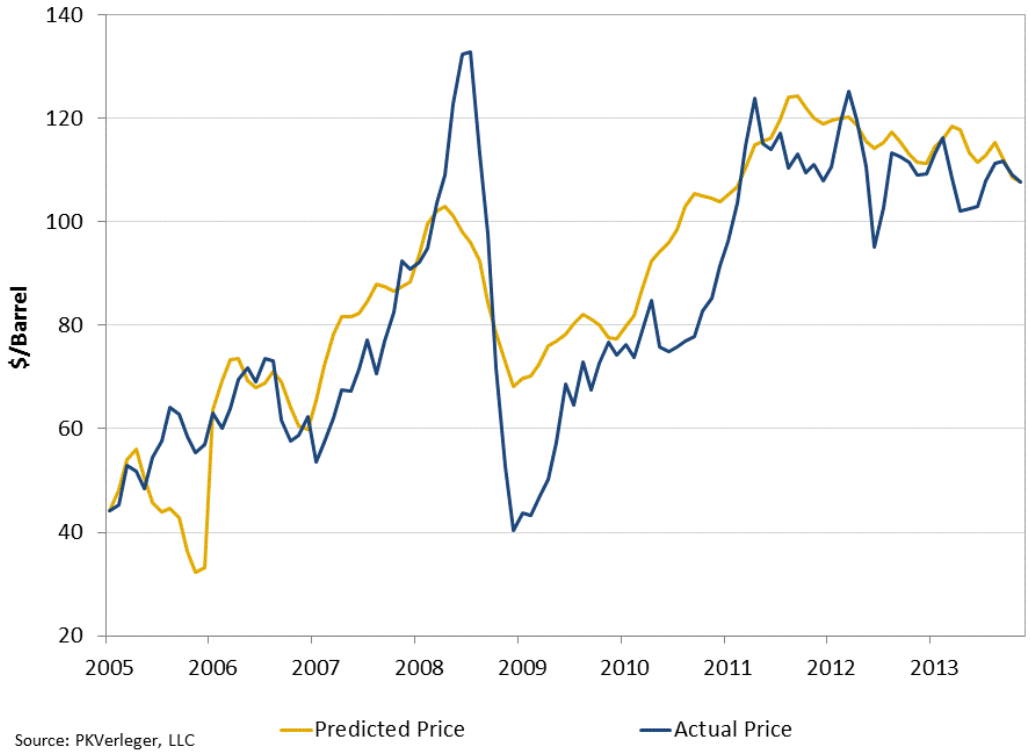
We tested the model using an iterative process that predicted the price level based on the model's forecast of the price change from period to period. We did not correct for errors. We calculated the predicted price for period t, Pt*, using the prediction for the prior period, Pt-1*, plus the prediction of the price change from t-1 to t generated by the model.

Figure 3 shows the model's prediction of DB prices. As the graph illustrates, the model did a reasonable job of predicting the DB price when the forecast was generated using the iterative process. The prediction explained 80% of the price variance without correcting for errors, and predicted prices tracked actual prices closely between 2011 and 2013. In fact, the November 2013

[1] Through empirical testing, we determined that the month-to-month price fluctuations were affected differently during three 4-month seasonal periods: January to April, May to August, and August to December. Additional empirical testing indicated that the change in inverse days of supply in the current month as well as the three previous months also influenced the crude price change. The lags may reflect a pass-through of information similar to what is also observed in retail petroleum markets.

DB price predicted by the model under observed conditions was $107.60 per barrel, almost exactly the price reported in the market.

Figure 3: Actual Dated Brent Prices vs. Predicted Brent Price Based on Inverse Days of Supply 2005–2013



Our results confirm that commercial inventories are an important predictor of price changes and price levels. A decline in stocks (which would cause days of supply to fall and inverse days of supply—the equation's explanatory variable—to rise) would be expected to boost prices. The magnitude of the increase would depend on the days of coverage. In this model, there is a nonlinear relationship between inventories and days of supply, with lower stock levels leading to larger price increases than higher stock levels. This finding is consistent with most economic research.

As a final point, we add that government stocks do not influence prices. We tested the model with a measure of government inventories—the days of coverage offered by these stocks—as an additional explanatory variable. The coefficients on the government stocks were all statistically insignificant. This result should not come as a surprise, as many analysts have noted that the management of public oil stockpiles has been terribly inept, and the data reveal that market participants pay no attention to changes in public crude oil holdings.